Economic Analysis

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Outsourcing and Offshoring in Canada

by John R. Baldwin and Wulong Gu

No. 055

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by
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11F0027MIE No. 055
ISSN: 1703-0404
ISBN: 978-0-662-48705-0

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May 2008

The authors would like to thank Daniel Trefler for helpful comments.

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Published by authority of the Minister responsible for Statistics Canada

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Abstract

This paper has three main objectives. First, it presents the long-term trends in outsourcing and offshoring across Canadian industries. Second, it examines the relationship between offshoring and changes in trade patterns at the industry level. It focuses on two major drivers that some have suggested are behind the recent trends toward offshoring: globalization and technological changes associated with information and communications technologies. Third, the paper examines the economic impact of offshoring by investigating the relationship between the extent of offshoring and productivity growth, shifts to high value-added activities and changes in labour markets.

Keywords: offshoring, productivity, employment

Executive summary

Outsourcing involves moving production outside of a firm. Offshoring entails sourcing part of the purchased inputs outside of the country.

Outsourcing decisions affect the boundaries of the firm—what production takes place within the firm and what is purchased from outside the firm.

Changes in offshoring may be, but are not necessarily, related to changes in outsourcing. They involve decisions both to purchase outside the firm and to do so from abroad. Considerations to do the latter are at the heart of the study of international trade.

Interest in outsourcing arises because it may presage changes in industrial structure. Interest in offshoring arises because it may signify changes in international trading patterns.

The paper focuses on three areas.

First, the paper presents data on long-term trends in outsourcing and offshoring across Canadian industries, using detailed industry data derived from Statistics Canada's input–output tables. It asks whether there is evidence of changes in outsourcing or offshoring patterns. It finds:

1) While concern about material outsourcing has been expressed, there has been little change in the ratio of material inputs to gross output over the period from 1961 to 2003. There is little evidence that changes in the boundary of the average firm is occurring when it comes to materials purchases.
2) But there has been a trend to service outsourcing. Service outsourcing has increased in almost all industries. The rate of growth was highest in service industries.
3) With post-Second World War trade liberalization, there has been a steady growth in the offshoring of material and service inputs. Canadian industries have purchased an increasing share of material and service inputs from abroad. Increases in the import share of material and service inputs have been pervasive across industries. The share of imports in material inputs almost doubled while the share of imports in service inputs almost tripled from 1961 to 2003. Most of service offshoring has taken place in the service sector.
4) Business services represent the largest category of service inputs being offshored by the Canadian industries, followed by financial services and insurance services.
5) The increase in the share of imported service inputs in total material and service inputs is a result of both an increase in import intensity and an increase in the share of services inputs in total material and service inputs for all main categories of service inputs, except for business services. The import intensity of business services was virtually unchanged over time.
6) Most of the offshoring that occurs is with the United States, though there has been some increase over the last decade with developing countries.

Second, the paper examines the relationship between offshoring and changes in trade patterns using detailed industry data derived from the Capital, Labour, Energy, Materials and Services (KLEMS) database maintained by the Productivity Accounts. It focuses on two major drivers that some have suggested are behind the recent trends toward offshoring: globalization and technological change related to the use of information and communications technologies (ICTs). It finds:

1) The share of ICT intermediate inputs is positively related to growth in offshoring of both materials and services.
2) The results suggest that growth in both services and material offshoring reflects the continuing trend in globalization and integration of world economies. Material offshoring reflects the two forces of globalization: gains from exploiting comparative advantage; and, gains from the exploitation of scale economies in differentiated product lines. Service offshoring reflects the force of scale economies and product differentiation.

Third, the paper examines the economic impact of offshoring by investigating the relationship between the extent of offshoring and productivity growth, shifts to higher value-added activities and changes in labour markets. It finds:

1) Material offshoring is positively related to multifactor productivity (MFP) growth. In contrast, service offshoring is not related to MFP growth. The effect of material offshoring on productivity growth has changed little over time.
2) Service offshoring is positively related to increases in the ratio of value added to intermediate input. Material offshoring is not related to changes in the ratio of value added to intermediate inputs.
3) Service offshoring is positively related to an increase in ICT capital deepening. Material offshoring is not.
4) Service offshoring is not related to changes in the share of university-educated workers, material offshoring is associated with a decline in the share of university-educated workers.
5) Together these findings indicate that service offshoring is associated with a shift to higher value-added activities in Canadian industries. The growth in service offshoring is positively related to an increase in the ratio of valued added to intermediate inputs, and high-tech capital deepening. In contrast, we find that material offshoring is not associated with shifts to higher value-added activities. The growth in material offshoring is not related to the changes in the ratio of value added to intermediate input, and high-tech capital deepening. It is negatively related to the share of university-educated workers in total employment.
6) Material and services offshoring has no effect on employment in Canadian industries. The effect of offshoring on wage growth differs between material offshoring and service offshoring. Material offshoring is not related to wage growth. Service offshoring has a negative relationship with wage growth in the service sector, and it has little effect on wage growth in the goods-producing sector.

1 Introduction

Outsourcing involves moving a portion of production outside of a firm. Offshoring entails sourcing part of inputs outside the country.

While recent interest in outsourcing and offshoring has intensified with rapid economic development in China and India, both these phenomena are at the core of industrial economics—focusing on firm behaviour—and international economics—focusing on the reasons behind trade between nations.

Outsourcing decisions affect the boundaries of the firm—what takes place within the firm and what takes place outside the firm. Firms always face the choice between making or buying when it comes to the inputs that they need in order to produce their product. When they choose to make the inputs themselves, they essentially extend the boundary of the firm. When they outsource the input, they are restricting it. In the first case, the firm becomes more integrated; in the second case, disintegration occurs.

Asking what determined the boundaries of firm production, as opposed to the purchasing and assembly of parts, was the focus of Coase's classic 1937 article, where he argued that relative transaction costs lie at the heart of the decision—since firms that internalize production are substituting a set of external contracts at relative certain prices associated with arm's length contracts with an incomplete highly uncertain contract (a labour agreement) when they make the decision to make the input internally. Williamson (1975) extended this analysis to consider the many factors that influence the decision to internalize, as opposed to purchase from outside the firm.

One consideration that is sometimes discussed is the advantage of the division of labour in internal production—Adam Smith's example of the pin factory; but Stigler (1951) pointed out that specialization is not necessarily always associated with internal production even in Industrial England, since it was obtained across many establishments in the Birmingham small-arms gun trade, with each establishment performing one task and one assembler putting the parts together.

Offshoring may be, but is not necessarily, related to outsourcing. It involves decisions both to purchase outside the firm and to do so from abroad. Considerations to do the latter are at the heart of the study of international trade.

Decisions to outsource or to insource production are being made continually as firms experiment with the optimal balance between internal production and external purchases. Within an industry, alternate boundaries of the firm—alternate models of the firm—often exist side by side. For example, auto companies differ in terms of the percentage of parts that are made by in-house subsidiaries as opposed to third parties. Some airlines do most of their maintenance in-house; others purchase it at an arm's-length basis. What may have been the norm at one time can be modified, if the costs and benefits of outsourcing change. Williamson notes functions that are not easily standardized, where external contracts are difficult to supervise and costly should they break down are often done internally. But even then, some external parts in these areas may still be outsourced so as to maintain a discipline on the internal production process. Changes in the

degree of outsourcing that are moving in opposite directions are taking place continuously in the economy as technology changes, in order to make external production cheaper or to make internal production more desirable.

Recent interest in outsourcing is related to the notion that new forces are at work to change the production boundaries of firms. Progress in transportation technology that has reduced transportation costs, along with new information and communications technologies (ICT) that allow for improved coordination of geographically dispersed production processes, are seen to be leading to the disintegration of production processes.

At the same time, reductions in trade barriers over the last 50 years have led to increased trade. Some of this has led to increased imports of inputs to the production process. This, in turn, is seen to be contributing to more offshoring—the sourcing of inputs abroad.

One example of situations where the boundaries of the firm have narrowed is those instances where firms increasingly participate in supply chains that involve arm's-length transactions between third parties. Supply chains at first were mainly domestic, involving firms in the same country; subsequently, they have become global in scope as firms take advantage of differences in production costs and technologies across countries.

The disintegration of material inputs has been much more important than the disintegration of service inputs, as most services have been traditionally non-tradable (Feenstra and Hanson 1999). But the disintegration of service inputs and trade in service inputs has become increasingly more important since the mid-1980s, facilitated by the advances in ICT, which have dramatically changing the tradability of a set of information-centred services, launching a revolution in the tradability of services (UNCTAD 2004).

While there is considerable discussion of the outsourcing and offshoring issue in Canada, there have been few empirical studies of its size and impact. Trefler (2005) uses aggregate data and finds that service offshoring is a small fraction of all trade in goods and services, but it has grown at a much higher rate than the growth for trade in goods. He also finds that service offshoring in Canada is dominated by offshoring to the United States and the other Organisation for Economic Co-operation and Development (OECD) countries.

Morissette and Johnson (2006) find that the offshoring of business services has no effect on employment in Canada. Head and Ries (2006) find that service trade, like goods trade, is subject to strong distance effects and the remote supply of services remains limited. They also find that distance costs are declining over time for some categories of service trade. Yan (2006), using a panel regression on the levels of employment shares, finds that foreign outsourcing has increased the demand for non-production workers relative to production workers in the Canadian manufacturing sector.

While there are few empirical studies on offshoring for Canada, there are a large number of studies for the United States and other OECD countries. Olsen (2006) provided a survey of empirical studies on the impacts of offshoring on productivity growth. He concludes that there is no clear pattern as to how offshoring affects productivity. Hartzichronoglou (2006) reviewed

empirical studies on the impact of offshoring on labour markets and concluded that offshoring has little effect on employment.

This paper makes a number of contributions to empirical studies on offshoring. First, it provides empirical evidence for Canada for the period since 1961. Second, this paper extends previous studies on service offshoring to include the service-producing industries. Most previous empirical studies on service offshoring have focused on the manufacturing industries, due to the lack of consistent time-series data for the service sector. This is unfortunate, as most service offshoring is undertaken by the service-producing industries. To fill this gap, this paper examines service offshoring in both the manufacturing and services sectors. Third, this paper provides empirical evidence on the effect of offshoring on shifts to high value-added activities. The discussions on service offshoring have focused on service offshoring as a route for firms and industries to move up the value chain (Sako 2006). But there is little empirical evidence on the effects of offshoring on shifts to high value-added activities.

The main data for the empirical analysis is a detailed set of industry data using the KLEMS (Capital, Labour, Energy, Materials and Services) database maintained by the Productivity Accounts at Statistics Canada. This industry database provides consistent time series data on gross output, capital input, labour input, and energy, material and service intermediate inputs for industries based on the 1997 North America Industry Classification System (NAICS) (Baldwin, Gu and Yan 2007).

For the purpose of this paper, we have developed a measure of offshoring by industry that has been merged with the KLEMS database. The measure represents the imported portion of material and services inputs and has been used in previous studies on offshoring (e.g., Feenstra and Hanson 1996, 1999; Amiti and Wei 2005; and Morissette and Johnson 2006).

2 Trend in offshoring and outsourcing

The term 'offshoring' or 'foreign outsourcing' implies shifts in intra-firm or intra-plant supplies to outside providers in a foreign country. The consequence of such a decision is the reallocation of jobs and production to a foreign country. The term 'outsourcing' includes both offshoring and domestic outsourcing which takes place when outside providers are located in the same country. Outsourcing does not necessarily imply that jobs and production are relocated to another country (Garner 2004).[1]

Outsourcing increases the amount of churn in an economic system. It will lead to each firm producing a small part of the final product. When disintegration in the economic process takes place, a firm purchases more of its inputs and creates less value added in the total production chain by itself.

1. There is no commonly accepted definition of offshoring in the public debate or in the economic literature. The definition we have adopted is used in most empirical studies on offshoring (Olsen 2006).

The input–output tables that are associated with the National Accounts produce estimates of gross value of output of all firms, the difference between output and input costs (termed value added) and the value of inputs purchased. Increased disintegration does not change the amount of value added produced across all firms, but it does increase the value of goods purchased and sold in total. Industries that are completely integrated will purchase nothing and only sell a final product. If the same industry is divided into many firms where each firm produces only a small part of the total product and ships on to the next firm, the total value of sales that are registered in the input–output tables will increase, as will the volume of inputs purchased, but the total value added will remain unchanged (unless productivity falls).

Changes in the degree of integration in the economic system then are revealed by changes in the ratio of inputs to outputs, or value added to shipments at the industry level and these will form the measure of outsourcing examined here.

For offshoring, we adopt the measure suggested by Feenstra and Hanson (1996, 1999):

$$offshoring_i = \sum_j \left[\text{input purchases of commodity } j \text{ by industry } i\right] * \left[\frac{\text{imports of commodity } j}{\text{production}_j + \text{imports}_j - \text{exports}_j}\right].$$

The second term in brackets is the average share of imports in domestic use across all users including industries, individuals and the public administration sector. The estimates of imported intermediate inputs by industry are based on the assumption that the average import share applies to all users.

This constant-import-share assumption will provide a good estimate of the size of offshoring for a commodity, if the commodity is mainly used for intermediate consumption. But the industry distribution of offshoring depends upon whether industries using the commodity have similar import propensities. Yuskavage, Strassner and Medeiros (2006) have compared the industry distribution of the resulting estimate of business services imports with a survey estimate. The two measures are quite similar when industries are defined at an aggregate level.

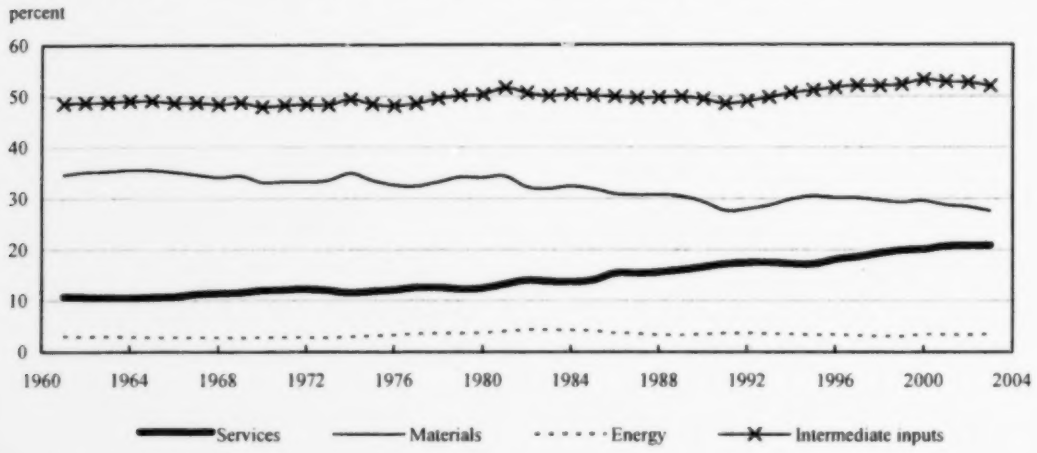
2.1 Outsourcing and offshoring in the aggregate business sector

Changes in material outsourcing and service outsourcing

Intermediate input as a fraction of nominal gross output in the Canadian business sector is plotted in Figure 1. Intermediate input is divided into materials, purchased services and energy inputs. The material input represents all commodity inputs exclusive of fuel (electricity, fuel oil, coal, natural gas and other miscellaneous fuels) but inclusive of fuel-type inputs used as raw materials in a manufacturing process, such as crude petroleum used by the refining industry. The service input consists of the following nine types: communications; finance and insurance; real estate rental; hotel services; repair services; business services, including equipment rental, engineering and technical services, and advertising; vehicle repair; medical and educational

services; and purchases from government enterprises. The energy input represents the various fuels purchased for use as heat or power including electricity, fuel oil, coal, natural gas, and other miscellaneous fuels.

Figure 1
The share of intermediate inputs in gross output in the business sector



Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

The share of intermediate inputs in the Canadian business sector shows a slight increase over time. Intermediate inputs accounted for 48.5% of gross output in 1961. In 2003, it accounted for 52.0%. This represents a 3.5-percentage-point increase from 1961 to 2003.

The purchased service inputs as a fraction of gross output showed a large increase over the period: it rose from 10.9% in 1961 to 20.9% in 2003—a 10.0-percentage-point increase over the period.

The share of purchased services increased in almost all industries, except in the miscellaneous manufacturing sector (see Appendix Table A.1). The industries with the largest growth are mostly within the service sector.

To ascertain if the share of purchased services increased because of a shift in industry composition, we decomposed the total change into two components: one from the changes in the service-input share taking place within industries, holding constant the industry composition; and the other from the shifts in the industry composition (Table 1). The results show that the increase in the service-input share within industries accounted for a 7.8-percentage-point increase or 78% of the change in the aggregate share of service inputs in output. The remaining 2.2-percentage-point change came from shifts in the industry composition of gross output toward services industries with relatively high service-input shares.

Material inputs, as a fraction of gross output in the aggregate business sector, declined over time—from 34.6% in 1961 to 27.6% in 2003. The 7.9-percentage-point decline was mostly the

result of a shift in the composition of output toward services-producing industries with low material-input share (as shown in Table 1). The within-industry contribution to the changes in the aggregate share of material inputs was small. This indicates that there were few changes in the share of material inputs in gross output at the industry level (see also Appendix Table A.2 that confirms this).

Table 1
Decomposition results for changes in the share of intermediate inputs in gross output in the total business sector, 1961 to 2003

	Total change	Within industry	Between industries
		percent	
Share of intermediate inputs in gross output	3.44	7.34	-3.90
Share of materials in gross output	-7.07	-1.42	-5.66
Share of services in gross output	10.03	7.79	2.24
Share of energy in gross output	0.48	0.97	-0.49

Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

The cost of energy inputs was a small share of gross output in the aggregate business sector. It increased over the period from 1961 to the early 1980s and then declined afterwards. Over the period 1961 to 2002, the share of energy inputs in gross output rose from 3.0% to 3.5%. The increase in the aggregate energy-input share is a result of increases taking place at the industry level.

In summary, while concern about material outsourcing has been expressed, there has been little change in the ratio of material inputs to gross output across the Canadian industries over the 1961-to-2003 period. There is little evidence that changes in the boundary of the average firm is occurring when it comes to materials purchases.

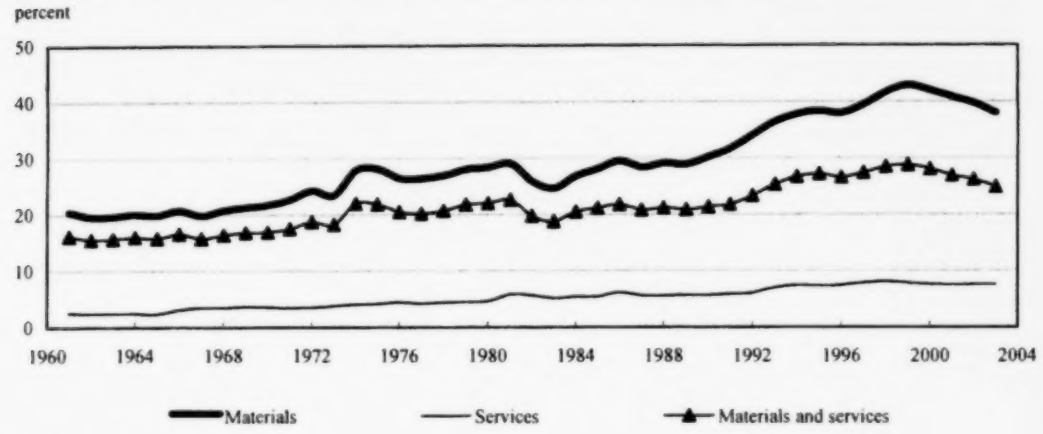
However, there has been a trend to service outsourcing. Service outsourcing has shown a dramatic increase across Canadian industries. Over the 1961-to-2003 period, the share of purchased services in gross output doubled.

Changes in material offshoring and service offshoring

Trends in the import share of material and service inputs in the aggregate business sector are plotted in Figure 2. With post-Second World War trade liberalization, there has been a steady growth in the offshoring of material and service inputs over time. Canadian industries have purchased an increasing share of material and service inputs from abroad. The share of imports in total material and service inputs increased from 16.2% to 24.9% over the 1961-to-2003 period.[2]

2. There has been a decline in the share of imported material inputs since the late 1990s, possibly due to the appreciation of the Canadian dollar that has made imports to Canada more expensive.

Figure 2
Import share of service and material inputs in the business sector, 1961 to 2003



Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

The share of imports in intermediate inputs can be decomposed into two components. The first component reflects the effect of changes in the share of imports in intermediate inputs at the industry level, holding constant the industry distribution of intermediate inputs. It is positive if there is an increase in the share of imports in intermediate inputs at the industry level. The second component represents the effect of shifts in the industry composition of intermediate inputs, holding constant the share of imports in intermediate inputs at the industry level. It is positive if there is a shift in the share of intermediate inputs toward the industries with relatively high import share of intermediate inputs.[3]

The results in Table 2 show that the increase in the share of imports in intermediate inputs in the total business sector is entirely due to the increase in the share of imports in intermediate inputs at the industry level over the period from 1961 to 2003. Of the 8.8-percentage-point increase in the import share of total material and service inputs over the period, the increase in the import share of intermediate inputs within industries contributed 9.5-percentage-points of the increase (Table 2). The shift in industry composition made a small and negative contribution to the overall changes.

3. This is the standard shift-share analysis.

Table 2
Decomposition results for changes in the share of imports in intermediate inputs in the total business sector, 1961 to 2003

	Total change	Within industry	Between industries
		percent	
Share of imports in total non-energy intermediate inputs	8.67	9.48	-0.80
Share of imports in materials input	6.02	7.33	-1.31
Share of imports in services input	2.65	2.14	0.51

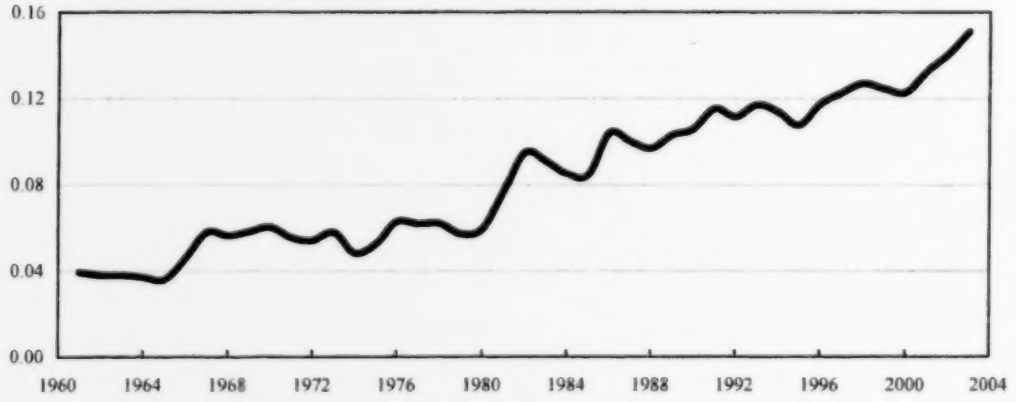
Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

The increase in import shares occurred for both material and service inputs. The share of imports in material inputs almost doubled, while the share of imports in service inputs almost tripled from 1961 to 2003. During that period, the import share rose from 20.5% to 38.0% for material inputs, while it rose from 2.6% to 7.6% for service inputs.

Over the 1961-to-2003 period, the import share of materials and the import share of service inputs both increased in almost all industries (Appendix Tables A.1 and A.2). The import share of material inputs increased by an average of 17.5 percentage points, while the import share of service inputs rose by 5.0 percentage points.

Most offshoring activities are in material inputs. Service offshoring is still at a relatively low level compared with material offshoring. In 2003, service-input imports were about 15% of material-input imports (Figure 3). But service offshoring is growing much more rapidly than material offshoring. From 1961 to 2003, the imports of service inputs increased at a rate 11.9% per year, while the imports of material inputs increased at a rate of 8.8% per year.

Figure 3
Ratio of service-input imports to material-input imports in the business sector



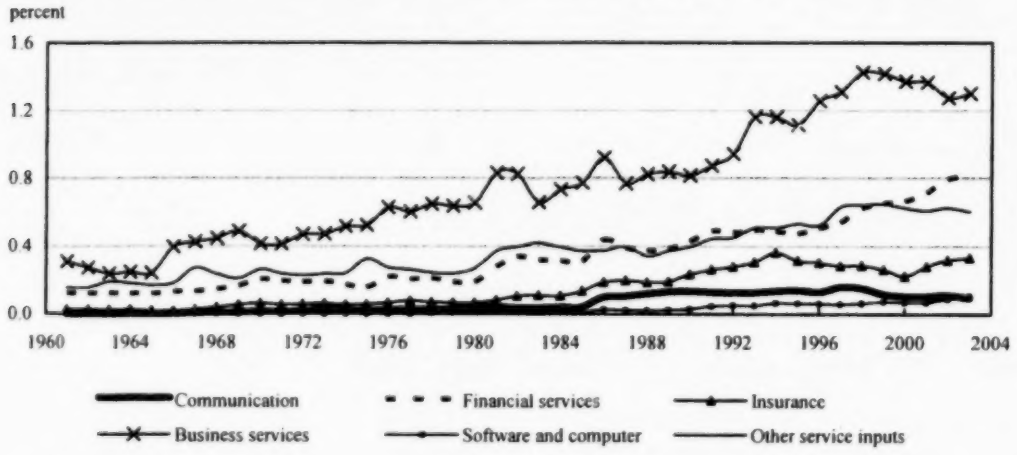
Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

Types of services being offshored

The trends in service offshoring since 1961 by types of service inputs are graphed in Figure 4. Service offshoring is calculated as the share of imported services in total material and service inputs.

We have divided service inputs into five main categories, plus a residual other service category. The five categories are: business services, except software and computer services; financial services; insurance; communication; and, software and computer services. Business services consist of (1) engineering, scientific, accounting and legal services; (2) software and computer services; (3) advertising services; and (4) other services to business. The financial services consist of other financial intermediation and real estate services, and imputed service charges, banks and other deposit-accepting intermediaries.

Figure 4
Service imports in total material and service inputs by type in the business sector



Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

Figure 4 shows that service offshoring increased in all five categories of service inputs over the 1961-to-2003 period. The share of imported business services in total material and service inputs increased from 0.3% to 1.3% over the period (Figure 4). The share of imported financial services rose from 0.1% of total non-energy inputs to 0.8%. The share also increased for insurance, communication, software and computer services, but the increase was much smaller here.

The increase in the share of imported service inputs in total material and service inputs is a result of both an increase in import intensity and an increase in the share of services inputs in total material and service inputs for all main categories of service inputs, except for business services.[4] The import intensity of business services was virtually unchanged over time (Table 3).

As shown in Figure 4, business services represent the largest category of service inputs being offshored by Canadian industries, followed by financial services, and insurance services. The offshoring of communication, software and computer services is less important.

Table 3
Changes in the share of imported service inputs in total material and service inputs in the business sector, 1961 to 2003

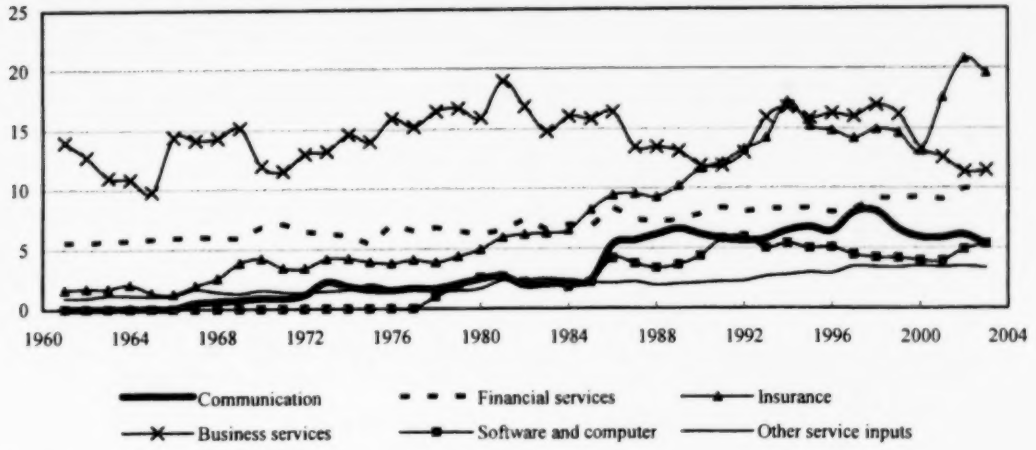
	Total changes	Changes in import share of the service input	Changes in share of the service input in total material and service inputs
Share of imports in the following service inputs in total material and service inputs		percent	
Communication	0.10	0.08	0.01
Financial	0.70	0.23	0.46
Insurance	0.31	0.29	0.02
Business services	0.99	-0.17	1.16
Software and computer	0.11	0.06	0.05
Other service inputs	0.45	0.42	0.03

Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

While the overall level of service offshoring by Canadian industries is still fairly low, the practice has become quite significant for business services (excluding software and computer use), financial services, and insurance (Figure 5). From 2000 to 2003, 12.2% of business service input was imported from foreign countries, and 17.7% of insurance services and 9.6% of financial services were imported from abroad.

4. Changes in the share of imported services in total inputs can be decomposed into two components. The first component is the effect of the changes in import intensity, which is calculated as the changes in the shares of imports in services inputs times the average share of services inputs in total inputs. The second component represents the effect of changes in the share of service input in total inputs, calculated as the changes in the share of service inputs in total inputs times the average share of imports in service inputs.

Figure 5
Import intensity by type of service inputs in the business sector, 1961 to 2003



Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

Table 4 contains the top 15 categories of service inputs with the largest imports, according to the detailed commodity aggregation provided by the input–output tables. Various types of business services are among the top 10 categories of service inputs with the largest dollar value of imports. In 2003, Canadian industries offshored 7.3 billion dollars in business services, accounting for 25.7% of total service-input imports. The offshoring of engineering, scientific, accounting and legal services amounted to 4.0 billion dollars in 2003 and accounted for 14.0 % of total service imports. The offshoring of software and computer use, and advertising services was small.

Table 4
Imports and exports in services,[1] 2003

Types of commodities	Imports of services used as inputs	Share in imports of service inputs	Imports of services for inputs and final demand	Exports of services for inputs and final demand
	$ millions	percent	$ millions	$ millions
Other services to business and persons	7,294	25.74	8,493	11,057
Other financial intermediations and real estate (non-rent) services	6,789	23.96	10,472	4,129
Engineering, scientific, accounting and legal services	3,954	13.95	4,645	4,197
Insurance	2,894	10.22	6,900	4,809
Software development, computer service and rent	940	3.32	1,692	5,030
Motion picture, audio and video services	845	2.98	1,160	1,113
Telephone and other telecommunications	752	2.65	1,367	1,443
Rental, video and recording equipment, other machinery and equipment	722	2.55	1,065	494
Air transportation	680	2.40	3,935	2,992
Truck transportation	608	2.14	1,832	3,345
Postal services	582	2.05	824	916
Implicit service charges, banks and other depository credit intermediations	336	1.19	844	1,569
Rental of automobiles and trucks	295	1.04	404	522
Water transport	225	0.79	499	1,217
Repair service for machinery and equipment	193	0.68	351	1,599
All other services	1,227	4.33	17,413	14,665
Sum	**28,335**	**100**	**61,894**	**59,096**

1. Ranked by the size of imports in service inputs.
Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

The business sector offshored 7.1 billion dollars in financial services in 2003, accounting for 25.3% of total services.

The offshoring of insurance services was 2.9 billion dollars in 2003. Together, the businesses services, financial services and insurance accounted for 78.5% of service offshoring by Canadian industries.

Table 4 also contains total imports and exports by categories of services, which covers total imports and exports by individuals, business sectors and non-business sectors. When imported service inputs are large relative to total imports, there is little final consumption. It is evident that the majority of imports in business services (lines 1, 2, 3 and 5) are for intermediate use by industries of the business sector. Only a small portion of imports in business services was for personal consumption and intermediate consumption by the non-business sector.

About 55% of total imports in financial and insurance services are used for intermediate inputs (offshoring).

Services offshoring by trading partners

The distribution of imports in commercial services by trading partners is presented in Table 5. Imports in commercial services include those used for intermediate inputs (or service offshoring) as well as those used for individual and government consumption. Since most commercial service imports are used for intermediate inputs by the business sector, its distribution by trading partners provides a reasonable indicator of the main providers of service offshoring in Canada.

Table 5
The share of services imports by trading partners

	1973	1990	2006
Share of services imports originating from		percent	
United States	78.00	72.37	68.10
United Kingdom	7.54	6.70	3.96
Foreign countries other than United States and United Kingdom	14.53	20.93	27.94
Other European Union countries	5.00	5.70	8.03
Japan	1.51	1.52	6.47
Other OECD[1] countries	2.19	3.31	2.56
All other countries	5.96	10.39	10.88

1. Organisation for Economic Co-operation and Development
Notes: Other European Union countries include Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain; and from January 1995, it includes Austria, Finland, and Sweden. Other Organisation for Economic Co-operation and Development countries include Australia, Iceland, New Zealand, Norway, Switzerland, Turkey; from July 1994, Mexico; from December 1995, the Czech Republic; from May 1996, Hungary.
Source: Statistics Canada, Balance of Payments.

Most Canadian offshoring of services is with the United States and the other high-wage countries. Service offshoring to low-wage countries represents a small portion of service offshoring in Canada, but it has increased its share over time. The share of commercial services imports originating from non-OECD (Organisation for Economic Co-operation and Development) or non-European countries, which include China, India and other low-wage countries, increased from 6.0% in 1973 to 10.9% in 2003.

From 1990 to 2005, the share of service imports from the low-wage countries was virtually unchanged. This is in a sharp contrast to material imports from low-wage countries. Over the last 15 years, the share of material imports from low-wage countries showed a dramatic increase (Goldfarb and Beckman 2007).

2.2 Outsourcing and offshoring at the industry level

In this section, we present trends in offshoring and outsourcing at the industry level. For this purpose, we have divided the business sector into three major sectors: two goods-producing sectors (the primary and construction sector, and the manufacturing sector); and service-producing sectors.

Trends in outsourcing in major sectors

Trends in outsourcing of materials and services inputs are presented in Table 6. To examine if the trend has changed over time, we have divided the 1961-to-2003 period into two of equal length: 1961 to 1982 and 1982 to 2003.

Table 6
The percentage share of intermediate inputs in gross output by major sectors, 1961, 1982 and 2003

	1961	1982	2003	Change 1961 to 1982	Change 1982 to 2003
	Total non-energy intermediate inputs				
Primary and construction	43.17	40.14	44.20	-3.03	4.06
Manufacturing	61.26	67.42	65.95	6.15	-1.47
Services-producing sector	28.96	30.49	37.99	1.54	7.49
	Service outsourcing				
Primary and construction	6.43	9.85	13.02	3.42	3.17
Manufacturing	7.18	7.88	10.41	0.71	2.53
Services-producing sector	18.09	22.54	31.51	4.45	8.97
	Material outsourcing				
Primary and construction	36.73	30.29	31.18	-6.45	0.89
Manufacturing	54.09	59.53	55.54	5.44	-3.99
Services-producing sector	10.87	7.95	6.47	-2.91	-1.48
	Addendum – Share of services in non-energy inputs (percent)				
Primary and construction	14.91	24.55	29.46	9.64	4.91
Manufacturing	11.71	11.69	15.78	-0.02	4.09
Services-producing sector	62.48	73.92	82.96	11.45	9.03

Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

The share of material and service inputs in gross output was highest in the manufacturing sector, and was the lowest in the services sector. In 2003, the cost of material and services input accounted for 66.0% of gross output in the manufacturing sector. It accounted for 38.0% of gross output in the service sector. But the service sector experienced the highest growth in non-energy intermediate input intensity over time. Further, the growth was accelerating over time. For the 1961-to-2003 period, the share of material and service inputs increased from 29.0% to 38.0%, which represents a 9.0-percentage-point increase. Most of the growth in the non-energy intermediate inputs occurred in the second half of the period. Changes in technology or changes in the types of products that were needed for the production of output in the service sector has led to more radical changes in the nature of firm boundaries in the service sector.

The composition of non-energy intermediate inputs differed by industry. In the service sector, most of non-energy intermediate inputs represent the cost of purchased services. In contrast, most of non-energy intermediate inputs in the goods sector come from material inputs. Purchased services accounted for 83.0% of total non-energy inputs in the services sector in 2003. It accounted for 29.5% of total non-energy inputs in the primary and construction sector and 15.8% in the manufacturing sector.

There has been a steady increase in the share of service inputs in the goods-producing and service-producing sectors. The share of services inputs in total non-energy inputs increased from 62.5% to 83.0% in the service sector over the 1961-to-2003 period. It rose from 14.9% to 29.5% in the primary and construction sector over the period.

The share of services inputs in total non-energy inputs rose from 11.7% to 15.8% in the manufacturing sector. Most of the increase occurred after the early 1980s. Since the early 1980s, manufacturing firms have increasingly outsourced less efficient service activities in order to focus on their core competencies (Siegel and Griliches 1992; Fixler and Siegel 1999).

Trend in offshoring in the major sectors

Trends in offshoring are presented in Table 7 for the three major sectors: primary and construction; manufacturing; and services. Service offshoring is mostly in the service-producing sectors, and it has also grown the fastest in the services sector (Figure 6). In 2003, service offshoring in the service sector accounted for 70.0% of overall service offshoring in Canada (Table 8).

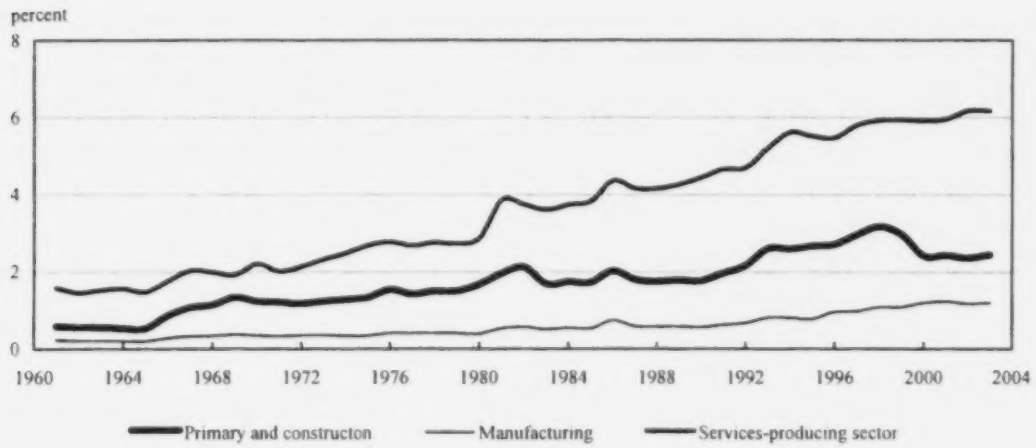
Table 7
The percentage share of imports in intermediate inputs by major sectors, 1961, 1982 and 2003

	1961	1982	2003	Change 1961 to 1982	Change 1982 to 2003
	Offshoring of materials and services				
Primary and construction	13.39	13.81	20.25	0.43	6.44
Manufacturing	22.09	28.05	38.85	5.97	10.80
Services-producing sector	4.80	7.83	10.19	3.03	2.36
	Service offshoring				
Primary and construction	0.58	2.12	2.44	1.54	0.32
Manufacturing	0.22	0.56	1.20	0.34	0.64
Services-producing sector	1.58	3.74	6.17	2.15	2.43
	Material offshoring				
Primary and construction	12.81	11.69	17.82	-1.12	6.13
Manufacturing	21.86	27.49	37.65	5.63	10.17
Services-producing sector	3.21	4.09	4.02	0.88	-0.07
	Addendum – Share of services in the material and service offshoring (percent)				
Primary and construction	4.33	15.37	12.04	11.04	-3.33
Manufacturing	1.02	2.01	3.09	0.99	1.08
Services-producing sector	33.01	47.74	60.54	14.72	12.80

Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

Material offshoring is largest in the goods-producing sector, and it has grown the fastest in the goods sector (Figure 7). In 2003, imported material inputs in the services sector accounted for about 7.0% of overall imports in material inputs (Table 8). The low level of material offshoring in the service sector is due to a small share of material inputs in the service sector.[5]

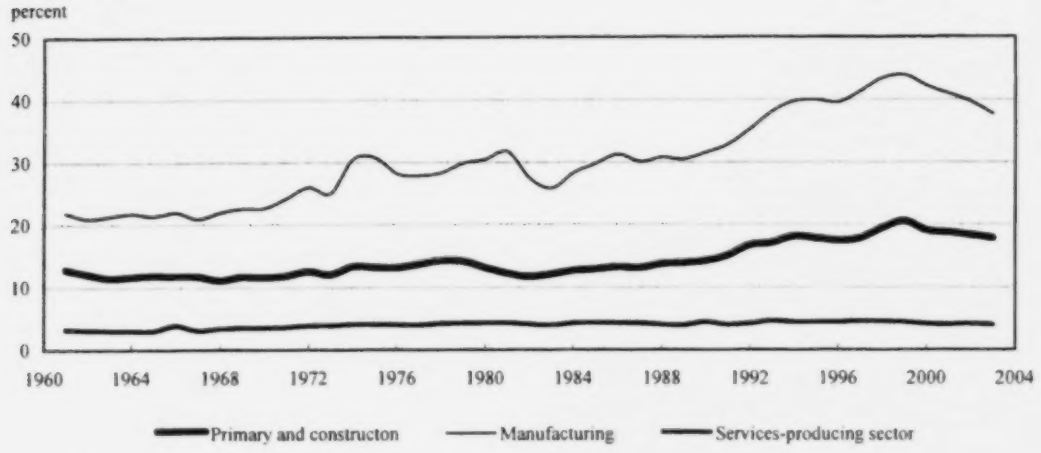
Figure 6
Share of imported services in total material and service inputs by sector, 1961 to 2003



Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

5. The import intensity (share of imported services in total services inputs) is similar between the manufacturing and services sectors.

Figure 7
Share of imported material inputs in total material and service inputs by sector, 1961 to 2003



Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

Table 8
Industry distribution of imports in service inputs and material inputs (in percentage), 1961, 1985 and 2003

	1961	1985	2003
	Service offshoring		
Primary and construction	21.7	22.4	13.6
Manufacturing	20.0	16.9	16.5
Service-producing sector	58.3	60.6	69.9
	Material offshoring		
Primary and construction	18.8	14.1	15.0
Manufacturing	76.5	80.1	78.2
Service-producing sector	4.6	5.8	6.9

Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

3 Determinants of offshoring

Previous studies have identified two main determinants of the growth in offshoring: advances in information and communications technologies (ICTs); and the continuing integration and globalization of production processes (Bartel, Lach and Sicherman 2005; Garner 2004; Trefler 2005).

Information technologies have changed the nature of the production process. For example, cost reductions in telecommunications have permitted call centres to be created far from the

production and marketing operation centres of North American companies. But ICTs have also changed the cost of coordination and thus they may have changed the balance between internal versus external production. Finally, new ICT technology itself may have created the need for external specialists to produce new and more sophisticated final products—service specialists that are outside the corporation and who need to be hired on an occasional basis to design products or to create systems.

To examine the relationship between globalization, the use of ICTs and offshoring of material and services inputs in Canada, we estimate the following regression on a sample of industries:

$$\Delta os_{it} = \alpha_o + \alpha_1 \Delta trade_{it} + \alpha_2 \Delta ICT_{it} + \delta_i D_i + \delta_t D_t + \varepsilon_{it},$$

where Δ denotes first differences between periods, os_{it} is the extent of offshoring in industry i in period t, *trade* measures trade openness, ICT_{it} is ICT intensity, and D_i and D_t are a set of dummies for industry and period fixed effects.

We follow most other studies on offshoring and define the offshoring variable *os* as the ratio of imports in the cost of total material and services inputs (Amiti and Wei 2005; Görg and Hanley 2005, 2003). To examine if the effect of trade integration and ICT on offshoring is different between the service and material inputs, we estimate two separate regressions: one for service offshoring and the other for material offshoring. Service offshoring is defined as the share of imports in total service inputs. Similarly, material offshoring is defined as the share of imports in total material inputs.

We make use of two separate indices that together indicate the degree of trade openness, because we are interested in the effect of changes in trade that occurs within industries—or intra-industry trade—and trade between industries—or inter-industry trade.

The measure of the intra-industry trade intensity used is that suggested by Grubel and Lloyd (1975). For an industry i with exports X_i, imports M_i and gross output Y_i, the index is $I = [(X_i+M_i) - |X_i - M_i|]/Y_i$. This is the ratio of intra-industry trade to nominal gross output.

The measure of inter-industry trade intensity is the ratio of the difference between total trade (exports and imports) intensity—$(X_i+M_i)/Y_i$—and intra-industry trade intensity.

The causes of intra-industry trade are thought to be different from the causes of inter-industry trade. The inter-industry trade variable reflects the force of comparative advantage arising from the difference in factor endowment and technologies. Countries engage in inter-industry trade to exploit benefits from comparative advantages. In contrast, intra-industry trade reflects the force of scale economies and product differentiation within industries. Intra-industry trade or trade in differentiated products takes place to exploit the benefits from economies of scale and specialization within individual product lines in particular industries.

ICT intensity is measured in two ways. First, we use the share of ICT intermediate inputs in total intermediate inputs; second, we use the share of ICT investment in total investment. ICT

intermediate input consists mainly of computer services, semiconductors and other electronic components that are used as intermediate inputs (see Appendix Table A.3). ICT investment consists of investment in computers, telecommunication equipment and software. While most studies interested in ICT focus on ICT investment, Beckstead, Burrows and Gellatly (2007) point out that the intensity of the consumption of intermediate inputs is not perfectly correlated with investments in ICT. The intensity with which these inputs are consumed may determine the extent of substitution possibilities for offshoring production.

To estimate the regression equation, we have divided the 1961-to-2002 period into eight periods of about equal length. These periods include seven of five years and one of seven years. The last period covers the seven years from 1996 to 2003. In all the empirical analysis in this paper, we have chosen this 'long-difference' specification. The data in a short-difference form such as annual difference are more likely to be subject to measurement errors. Further, the short-difference specification does not capture lagged effects unless the lagged independent variables are introduced in the specification.

In all specifications, we include period-fixed effects and industry-fixed effects. The period-fixed effects control for any unobserved time-varying effects common across all industries. Industry-fixed effects control for any unobserved industry characteristics that may affect offshoring, ICT use and trade openness at the same time. For example, there are high-growth industries that invest more in ICT, trade more in goods and services and offshore more inputs to other countries.[6]

The sample consists of a panel of 88 industries of the business sector from 1961 to 2003. The summary statistics on the main variables are presented in Table A.4 in the appendix.

The results, using Ordinary Least Squares, are presented in Table 9. The share of ICT intermediate inputs is positively related to growth in offshoring in material and service. The correlation is statistically significant at the 5% level. In contrast, the share of ICT investment is not related to growth in offshoring activities in Canadian industries. It is the production process that is related to intermediate factor proportions rather than capital intensity that is more closely related to changes in offshoring at the industry level.

6. We have estimated the regression without industry fixed effects. The results are similar.

Table 9
Regression results on the determinants of offshoring

	(1)	(2)	(3)
Trade openness	0.285	...	...
	(7.43) **	...	...
Intra-industry trade	...	0.203	0.205
	...	(4.95) **	(4.97) **
Inter-industry trade	...	0.37	0.37
	...	(7.16) **	(7.17) **
ICT[1] intermediate inputs	0.700	0.712	0.706
	(3.98) **	(4.04) **	(3.95) **
ICT investment	...	...	-0.040
	...	...	(1.00)
Observations	613	613	613
R-squared	0.37	0.38	0.38

... not applicable
** significant at 1% level
1. Information and communications technologies.
Notes: Authors' calculations from data. Robust t-statistics in parentheses.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

Trade openness is an important source of growth in offshoring. A 1-percentage-point increase in the trade–output ratio is associated with a 0.3-percentage-point increase in the ratio of imports in total material and services inputs.

When we divide trade into intra-industry trade and inter-industry trade, we find that both intra-industry and inter-industry trade are positively related to offshoring. But the effect of intra-industry trade on offshoring is about two times as large as the effect of inter-industry trade. This indicates that offshoring largely reflects the force of scale economies and gains from product specialization that come from increasing intra-industry trade.

In Table 10, we examine the determinants of service and material offshoring separately. Increases in intra-industry trade are the main sources of growth in offshoring for both material and services inputs. Growth in inter-industry trade is related to growth in material offshoring, but is not related to service offshoring. The increase in trade openness and globalization tends to have a larger impact on material offshoring than on service offshoring.

Table 10
Regression results on the determinants of material and service offshoring

Dependent variable	Service offshoring	Service offshoring	Material offshoring	Material offshoring
Intra-industry trade	0.015	0.014	0.355	0.356
	(2.50) *	(2.38) *	(6.85) **	(6.88) **
Inter-industry trade	-0.003	-0.004	0.207	0.207
	(0.55)	(0.59)	(5.15) **	(5.14) **
ICT[1] intermediate inputs	0.042	0.062	0.67	0.649
	(1.60)	(2.07) *	(3.89) **	(3.45) **
ICT intermediate input × goods sector dummy	...	-0.101	...	0.107
	...	(1.39)	...	(0.23)
Observations	613	613	613	613
R-squared	0.39	0.39	0.35	0.35

... not applicable
* significant at 5% level
** significant at 1% level
1. Information and communications technologies.
Notes: Authors' calculations from data. Robust t-statistics in parentheses.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

ICT intermediate input is closely related to service offshoring, and it is more important for growth in service offshoring in the service sector than in the goods sector. The evidence also shows that ICT intermediate input is closely related to material offshoring, and it tends to be more important for the growth in material offshoring in the goods sector than in the services sector.

To sum up, the results suggest that growth in both services and material offshoring reflects the continuing trend in globalization and integration of the production process of world economies. Material offshoring reflects the two forces of globalization: gains from exploiting comparative advantage and gains from the exploitation of scale economies in differentiated product lines. Service offshoring reflects the force of scale economies and product differentiation.

One form of comparative advantages is low production costs and low wage costs in foreign countries. Our results suggest that the low production costs and the low wage costs in foreign countries are important sources of growth in service offshoring. But our results also suggest that the force of scale economies is also an important source in service offshoring by Canadian service industries, which is often neglected in recent discussions about service offshoring.

4 Economic impact of offshoring

In this section, we examine the impact of offshoring on economic performances. We focus on the impact of offshoring on productivity growth, shifts to high-value activities and labour markets.

Earlier studies have examined the effects of offshoring on labour markets (Feenstra and Hanson 2001 for a review). The evidence for the United States suggests that offshoring has increased the demand for more skilled workers; but there is no consensus on the size of the effects of offshoring. Feenstra and Hanson find that offshoring can account for as much as three-fifths of the increase in the relative wages of non-production and production workers in U.S. manufacturing from 1979 to 1990. Other studies conclude that offshoring and trade in intermediate inputs are not important factors behind the increase in the relative demand for more-skilled workers.

More recent studies have focused on the effects of offshoring on employment. Some estimates suggest that offshoring has led to a large reduction in employment of white-collar workers in the United States (McCarthy 2002). But most empirical studies suggest that the overall impact of offshoring on employment levels is small (Amiti and Wei 2005; Mankiw and Swagel 2006).

A number of recent studies have also examined the effects of offshoring on productivity performance. The limited empirical evidence suggests that material offshoring has a positive effect on productivity growth. The evidence on the effects of service offshoring on productivity growth is mixed. But the preponderence of evidence suggests that service offshoring has little effect on productivity growth, possibly due to low levels of service offshoring compared with the level of material offshoring (see Olsen 2006 for a review). An exception is the paper by Amiti and Wei (2005) that finds that service offshoring has a significant positive effect on productivity in U.S. manufacturing, accounting for 11% of productivity growth for the 1992-to-2000 period.

The model that motivates our analysis of offshoring starts with an aggregate production function that expresses gross output as a function of intermediate input and value added, and value added is represented in turn as a function of capital input, labour input and time. The existence of the value-added aggregate requires that time and capital and labour inputs are separable from intermediate inputs.[7] This type of production function has been used most frequently in previous studies on productivity (see, for example, Jorgenson, Gollop and Fraumeni 1987).

The aggregate production is written as:

$$Y = F(A, X),$$

where Y denotes gross output, A denotes value-added, and X denotes intermediate inputs.

Value added is taken to be a function of capital input, labour input and time:

$$A = B(t)G(K, L),$$

7. See Triplet and Bosworth (2004). For a dissenting opinion, see Diewert (2005).

Where K denotes capital input, L denotes labour input. $B(t)$ is multifactor productivity and measures the efficiency with which capital and labour are combined in producing value added.

We assume that the value-added function exhibits constant returns to scale, and gross output is a constant elasticity of substitution production with respect to value added and intermediate input:

$$Y = \left[\alpha \left(B(t)G(K,L) \right)^{\frac{\sigma-1}{\sigma}} + (1-\alpha) X^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma-1}{\sigma}},$$

where, σ is the elasticity of substitution between value added and intermediate input and α is a production parameter that indexes the share of value-added in gross output.[8]

While intermediate input in this formulation is separable from capital input, labour input and time, the composition of intermediate inputs is taken to affect the value-added function. Our hypothesis is that the share of imports in material and services inputs affects multifactor productivity $B(t)$, and the index of the ratio of value added to gross output α.

There are several ways in which this can occur. In a world where specialization allows for superior products to be produced by independent contractors, use of these products rather than inferior, internally produced substitutes will improve efficiency. Or, the outside components may allow for superior products to be developed.

A portion of gains in productivity from offshoring should also be expected to come from plant turnover—the closedown and decline in less efficient plants that used to produce the inputs that are offshored.

Offshoring may have a positive effect on productivity performance through specialization and restructuring. Outsourcing occurs when firms opt to buy rather than make things in-house. Offshoring is a special form of outsourcing when the suppliers are located in foreign countries. Outsourcing and offshoring may lead to greater specialization and restructuring. If so, we would expect to find a positive relationship between outsourcing (offshoring) and productivity.

It is also possible that changes in input composition will allow a firm to move up the value-added chain. Production processes that are carried on within plants differ in terms of complexity—from those that require little skilled labour and/or transform raw materials at an early stage of the production process to those that require more capital, both machinery and equipment, and more highly skilled workers.

Sako (2006) makes a useful distinction between vertical disintegration of inputs and the unbundling of corporate functions in his discussion of outsourcing and offshoring. Vertical disintegration happens when a firm decides to buy rather than make, and when it is cheaper to source inputs that go into a firm's final product in the market rather than make them in-house.

8. The constant elasticity of substitution production function has been used extensively in research that examines changes in relative wages of skilled and unskilled workers and the role of skill-biased technological change (e.g., Katz and Murphy 1992).

For example, car manufacturers used to make many car components in-house at their parts divisions. But, by spinning out the parts divisions, car manufacturers now source major sections of the car—such as seats—from independent suppliers.

While material-input outsourcing is very much about the disintegration of inputs, service outsourcing is as much about the unbundling of corporate functions as vertical disintegration. Modern corporations have corporate functions, such as finance and accounting, human resources, sales and marketing, purchasing and supply, and research and development. While many processes in these functions are outsourceable, corporations typically outsource low value-added processes. High value-added processes are kept within the corporation.

For example, in human resource outsourcing, low value-added processes such as payroll and benefits administration are typically outsourced, while human resources strategy and other high value-added activities are not outsourced. In the finance and insurance functions, general accounting is the typical example of outsourcing that is given. But financial strategy and other high value-added activities are less likely to be outsourced.

All this suggests that an important effect of service offshoring is to shift to higher value-added activities. The shift to higher value-added activities as a result of offshoring will show up as an increase in the employment of knowledge occupations, or an increase in capital intensity—particularly high-technology capital intensity—of the operations, or a higher ratio of value added to intermediate input.

While our discussions so far have focused on the effect of service offshoring on shifts to higher value-added activities, material offshoring is also expected to have an effect on the size of higher value-added activities within firms. The effects of material offshoring on a shift to higher value-added activities may not be as strong as the effect of service offshoring. While offshoring of material inputs to developing countries involves inputs that are less capital- and skill-intensive, it is not obvious that the offshoring of material inputs to the United States and other developed countries would involve material inputs with lower value added. Since much of material offshoring in Canada is with the United States and other developed countries, the effect of material offshoring on the shift to higher value-added activities should be smaller than the effect of service offshoring.

To sum up, the offshorings of services and materials are both expected to raise productivity performance through the disintegration of inputs, product specialization and the exploitation of scale economies. Material offshoring is expected to have a larger effect on productivity growth than is service offshoring, as material offshoring is mainly about the disintegration of inputs while service offshoring is as much about the unbundling of corporate functions as the vertical disintegration of inputs.

Service offshoring is expected to result in a shift to high value-added activities as service offshoring very much involves the unbundling of corporate functions and offshoring of low value-added activities. The effect of material offshoring on the shift to higher value-added activities is less obvious.

The effects of offshoring on employment and wages are much less clear. To the extent that offshoring removes part of the production process that has specific characteristics, we might expect to see a relationship between offshoring and employment or wages in a specific subset of workers. Offshoring is often presumed to affect lower skilled workers. But we have already seen that the majority of Canadian offshoring is with the United States and the United States is not seen to have lower skill levels than Canada. When it comes to predicting the impact of offshoring on the demand for all workers, it is difficult to formulate expected hypotheses. Trade leads to lower demand for labour in industries or sectors affected by increased imports but to greater demand in areas whose exports are increasing.

4.1 The relationship between offshoring and productivity growth

To examine the effect of offshoring on productivity growth, we estimate the following equation derived from the value-added production function:

$$\Delta MFP_{it} = \alpha_o + \alpha_1 \Delta os_{it} + \alpha_2 ICT_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it},$$

where Δ denotes first differences between periods, MFP_{it} denotes multifactor productivity based on value added and measures the overall efficiency of capital and labour inputs in producing value added, os_{it} is offshoring in industry i in period t, ICT_{it} is information and communications technology investment intensity, and D_t and D_i are a set of dummies for industry and period fixed effects.

The offshoring variable os is defined as the ratio of imports in the cost of total material and services inputs. To examine if there are differential effects of material and service offshoring, we introduce service offshoring and material offshoring separately in the regressions.

To estimate the regression equation, we divided the 1961-to-2002 period into eight periods of about equal length.[9] In all specifications, we include period fixed effects and industry fixed effects. The period fixed effects control for any unobserved time-varying effects common across all industries. Industry fixed effects control for any unobserved industry characteristics that may affect offshoring and productivity growth at the same time. For example, there are high productivity-growth industries that offshore more inputs to other countries.

The main finding is that material offshoring is positively related to multifactor productivity (MFP) growth and the effect is statistically significant at the 5% level (top panel of Table 11). In contrast, service offshoring is not related to MFP growth.

Most material offshoring is in manufacturing industries. When we re-estimate the MFP equation on a sample of manufacturing industries, we find that the effect of material offshoring is larger in the manufacturing industries. The coefficient on material offshoring is 0.50 with a t-statistic of

9. The eight periods include seven of five years and one of seven years. The last period covers the seven years from 1996 to 2003.

2.31. This compares with the coefficient estimate of 0.43 on the material offshoring variable when the all-industry sample is used.

Table 11
Regression results on the effects of offshoring on multifactor productivity growth

	(1)	(2)	(3)	(4)	(5)
Specifications without the export growth variable					
Offshoring	0.404	...	...	...	...
	(1.98) *	...	...	...	...
Material offshoring	...	0.418	...	0.427	0.016
	...	(2.04) *	...	(2.09) *	(0.05)
Service offshoring	...	-1.132	-1.334	...	...
	...	(0.68)	(0.80)	...	...
ICT[1] intensity	0.04	0.038	0.037	0.040	0.043
	(1.51)	(1.45)	(1.41)	(1.50)	(1.62)
ICT × material offshoring	...	...	...	...	6.36
	...	...	...	...	(2.09) *
Observations	671	671	671	671	671
R-squared	0.34	0.35	0.34	0.35	0.35
Specifications with the export growth variable					
Offshoring	0.397	...	...	...	...
	(2.13) *	...	...	...	...
Material offshoring	...	0.412	...	0.428	0.107
	...	(2.20) *	...	(2.30) *	-0.37
Service offshoring	...	-1.667	-1.908	...	...
	...	(1.00)	(1.15)	...	...
ICT intensity	0.039	0.036	0.035	0.039	0.041
	(1.43)	(1.35)	(1.29)	(1.42)	(1.51)
Export growth	0.079	0.08	0.083	0.079	0.078
	(4.85) **	(4.94) **	(5.06) **	(4.86) **	(4.76) **
ICT × material offshoring	...	...	...	...	4.979
	...	...	...	...	(1.67)
Observations	657	657	657	657	657
R-squared	0.40	0.40	0.40	0.40	0.40

... not applicable
* significant at 5% level
** significant at 1% level
1. Information and communications technologies.
Notes: Authors' calculations from data. Robust t statistics in parentheses.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

For the manufacturing sector, material offshoring increased by 15.8 percentage points from 1961 to 2003. Our estimates suggest that the growth in material offshoring contributed 7.9% to total MFP growth over the period or 0.19 percentage points to annual MFP growth. Over this period, labour productivity increased at a rate of 2.96% per year in the manufacturing sector. The contribution of material offshoring accounted for about 6% of the labour productivity growth in the manufacturing sector.[10]

10. Amiti and Wei (2005) find that material offshoring accounted for 5% of labour productivity growth in the U.S. manufacturing sector over the 1992-to-2000 period.

To examine if the effect of material offshoring changed over time, we introduced an interaction term between the material offshoring variable and a period dummy for post-1981. The coefficient on the interaction term is not statistically significant, thereby indicating that the effect of material offshoring on productivity growth changed little over time.

While ICTs are not found to be a major determinant of the growth in offshoring, ICT may enhance the productivity benefits of offshoring. To test the hypothesis, we introduced an interaction term of ICT intensity with material offshoring. The coefficient is positive and statistically significant. This is consistent with the view that ICT facilitates offshoring and increases the gains from material offshoring.

Previous empirical studies in Canada find that exports are positively related to productivity using the plant-level data (Baldwin and Gu 2003, 2004). In the bottom panel of Table 11, we introduce real export growth as an additional control variable in the productivity regression.[11] The coefficients on the offshoring variables are virtually unchanged. The coefficient on the export growth variable is positive and statistically significant at the 1% level, which suggests that industries with faster export growth are the industries with higher productivity growth. This is consistent with the previous plant-level evidence on the positive effect of exporting on productivity growth.

4.2 The relationship between offshoring and shifts to high value-added activities

Our discussion indicates that service offshoring is expected to result in shifts to higher value-added activities, while the effect of material offshoring on shifts to higher value-added activities is less obvious.

To examine whether this is the case, we use three alternative measures to capture shifts to high value-added activities, since there is no commonly accepted criteria as to what constitutes higher value-added activities. The first measure is changes in the ratio of value added to intermediate inputs. The second measure is the change in the knowledge-worker share of employment, and the third measure is high-tech capital investment. As we do not have a consistent measure of knowledge workers over a long period, we use the share of university-educated workers in total employment as a proxy for the high knowledge content of employment.

Under the assumptions that there are constant returns to scale to the value-added aggregate and intermediate inputs and that markets are competitive, the ratio of marginal products between the value-added aggregate and intermediate inputs equals their relative prices. When gross output is a constant elasticity of substitution function of value-added and intermediate inputs, we can derive the following equation:

$$\ln(A/X) = \sigma \ln(\alpha/(1-\alpha)) - \sigma \ln(P_A/P_X),$$

11. Real exports are estimated from deflating nominal exports by gross output prices. The specification has been used in Bernard and Jensen (1999). The results from using nominal export growth are similar.

where P_A, P_X are the prices of value-added and intermediate inputs.

Offshoring has an effect of raising the index for the share of value-added α. Therefore, $\ln(\alpha/(1-\alpha))$ should be a positive function of service offshoring. Taking the first difference, we obtain the following equation for examining the effects of offshoring on the ratio of value added to intermediate inputs:

$$\Delta \ln(A/X)_{it} = \alpha_o + \alpha_1 \Delta os_{it} + \alpha_2 \Delta \ln(P_A/P_X)_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it},$$

The results on the effect of offshoring on the ratio of value added to intermediate inputs are contained in Table 12. Service offshoring is positively related to increases in the ratio of value added to intermediate input. Material offshoring is not related to changes in the ratio of value added to intermediate input.

Table 12
Regression results on the effects of offshoring on the ratio of value-added to intermediate inputs

	(1)	(2)	(3)	(4)	(5)
Offshoring	-0.001	...	...	...	...
	(0.00)	...	...	...	...
Material offshoring	...	-0.016	-0.045	...	0.034
	...	(0.09)	(0.26)	...	-0.18
Service offshoring	...	2.822	...	2.832	3.313
	...	(1.98) *	...	(2.00) *	(2.22) *
Relative price of value-added	-0.310	-0.308	-0.311	-0.307	...
	(7.25) **	(7.20) **	(7.25) **	(7.20) **	...
Observations	637	637	637	637	637
R-squared	0.31	0.32	0.31	0.31	0.25

... not applicable
* significant at 5% level
** significant at 1% level
Notes: Authors' calculations from data. Robust t statistics in parentheses.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

The coefficient on the relative prices of value added and intermediate input is the elasticity of substitution between value added and intermediate inputs. The coefficient estimates suggest that the elasticity of substitution between value added and intermediate inputs is about 0.3. This is less than 1—the elasticity of substitution from the Cobb-Douglas production function—but accords with the estimates that Bruno (1984) reports from his review of a number of empirical studies.[12]

The effects of service offshoring on the shifts to high value-added activities may differ between goods and services-producing industries. To test this hypothesis, we introduced an interaction term between service offshoring and a dummy variable for service industries. The coefficient on the interaction term is not statistically significant. This indicates that the effects of service

12. Bruno (1984) reports most estimates are between 0.3 and 0.4.

offshoring on shifts to higher value-added activities are similar between goods and services sectors.

The relationship between offshoring and shifts to higher value-added activities using the changes in the employment share of university-educated workers is contained in Table 13. Service offshoring is not related to increases in the share of university-educated workers. Material offshoring has increased in those industries where the share of university-educated workers has decreased.

Table 13
Regression results on the effects of offshoring on the relative employment of university-educated workers

	(1)	(2)	(3)	(4)	(5)
Offshoring	-0.492	...	...	...	...
	(3.10) **	...	...	...	...
Material offshoring	...	-0.48	-0.465	...	-0.479
	...	(3.03) **	(2.93) **	...	(2.96) **
Service offshoring	...	-1.906	...	-1.673	-2.189
	...	(1.64)	...	(1.44)	(1.80)
Relative wages of university-educated	-0.356	-0.353	-0.357	-0.353	...
	(4.03) **	(4.01) **	(4.03) **	(4.00) **	...
Observations	668	668	668	668	668
R-squared	0.46	0.46	0.45	0.45	0.43

... not applicable
** significant at 1% level
Notes: Authors' calculations from data. Robust t-statistics in parentheses.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

As material offshoring is mostly in the manufacturing industries, we have re-estimated the equation for the share of university-educated workers using the sample of manufacturing industries. The results from the manufacturing sample show a similar result. Material offshoring is negatively related to the changes in the share of university-educated workers.

The negative relationship between material offshoring and the employment of more educated workers could arise for a number of reasons. First, material offshoring and the resulting specialization may reduce the demand for more skilled non-production workers. Baldwin and Gu (2007) report that non-production workers were negatively affected by trade liberalization in the early 1990s. Second, the offshoring of material inputs is mostly to the United States and probably within multinational firms. Offshored material inputs from the United States may have a higher skill content than the products that are produced in Canada. As a result, material offshoring may have reduced the skilled worker share in Canadian production.

Table 14 examines the relationship between offshoring and high-tech capital deepening as measured by the growth in information and communications technology (ICT) capital services per hour worked. Since ICT became important after the early 1980s, we estimate the regression using the data for the 1982-to-2003 period. Service offshoring is found to be related to high-tech capital deepening.

Table 14
Regression results on the effects of offshoring on information and communications technology capital deepening

	(1)	(2)	(3)	(4)
Offshoring	0.248	...	...	...
	(0.26)	...	...	...
Material offshoring	...	0.217	0.071	...
	...	(0.22)	(0.07)	...
Service offshoring	...	13.108	...	12.93
	...	(1.80)	...	(1.77)
Observations	340	340	340	340
R-squared	0.3	0.31	0.3	0.31

... not applicable
Notes: Authors' calculations from data. Robust t-statistics in parentheses. The estimate is based on panel industries for the 1982-to-2003 period.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

To sum up, we find evidence that service offshoring is associated with a shift to high value-added activities in the Canadian industries. The growth in service offshoring is positively related to an increase in the ratio of valued added to intermediate inputs, and high-tech capital deepening.

In contrast, we find that material offshoring is not associated with shifts to higher value-added activities. The growth in material offshoring is not related to the changes in the ratio of value added to intermediate input, and high-tech capital deepening. It is negatively related to the share of university-educated workers.

The evidence on the effects of material offshoring reflects the fact that manufacturing industries are highly integrated between Canada and the United States. The main effect of material offshoring is found in productivity gains related to product specialization. But, as the manufacturing industries in Canada increasingly integrate themselves with industries in those countries with low wages, it is expected that material offshoring will lead to a shift to more high value-added activities. This could occur as the low-value added firms are displaced by the competition from cheap material inputs from the low-wage countries.

4.3 The relationship between offshoring, wages and employment

Offshoring in materials and service inputs results in increased imports from other countries. Like other imports, offshoring is expected to affect wages and employment in Canada.

To examine the effect of offshoring on employment, we estimate the following labour demand equation in first-difference form (Hamermesh 1993):

$$\Delta \ln L_{it} = \alpha_o + \alpha_1 \Delta os_{it} + \alpha_2 \Delta \ln W_{it} + \alpha_3 \Delta \ln Y_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}$$

We expect that increases in output will have a positive effect on employment growth and an increase in wages will have a negative effect on employment growth.

The results from estimating the employment equation are presented in Table 15. Material and services offshoring has no effect on employment in Canadian industries. The coefficients on the output and wage variables have the expected signs and are statistically significant.

As material offshoring is mostly in the manufacturing sector, we have re-estimated the employment equation using the sample of manufacturing industries. Once again, we find that material offshoring is not related to changes in employment in the sample of manufacturing industries.

To examine the relationship between offshoring and wages, we estimate the following equation:

$$\Delta \ln W_{it} = \alpha_o + \alpha_1 \Delta os_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}.$$

Table 15
Regression results on the effects of offshoring on employment

	(1)	(2)	(3)	(4)	(5)
Offshoring	-0.057	...	...	...	...
	(0.43)	...	...	...	...
Material offshoring	...	-0.05	-0.044	...	-0.058
	...	(0.37)	(0.33)	...	(0.42)
Service offshoring	...	-0.989	...	-0.967	0.276
	...	(0.95)	...	(0.93)	(0.25)
Output growth	0.601	0.601	0.601	0.6	0.577
	(19.77) **	(19.80) **	(19.78) **	(19.85) **	(17.25) **
Wage growth	-0.396	-0.402	-0.396	-0.402	...
	(7.66) **	(7.58) **	(7.64) **	(7.58) **	...
Observations	662	662	662	662	662
R-squared	0.76	0.76	0.76	0.76	0.72

... not applicable
** significant at 1% level
Notes: Authors' calculations from data. Robust t-statistics in parentheses.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

The estimating equation for changes in wages is a reduced form equation. A full examination of the effects of offshoring on worker wages requires a general-equilibrium model that distinguishes several effects: a labour-demand effect that captures the effect of reduced demand for the workers whose production activities are offshored; a terms-of-trade effect that captures the labour market implications of changes in relative prices due to changes in offshoring activities; and a productivity effect that captures the benefits of offshoring-led productivity gains on wages.[13]

The results (Table 16) indicate that material offshoring is not related to wage growth. Service offshoring is negatively related to wage growth.

13. Grossman and Rossi-Hansberg (2006) have developed a theoretical framework to examine those effects of offshoring on wages.

Table 16
Regression results on the effects of offshoring on wages

	(1)	(2)	(3)	(4)
Offshoring	-0.051	...	...	...
	(0.44)	...	...	...
Material offshoring	...	-0.034	-0.016	...
	...	(0.29)	(0.14)	...
Service offshoring	...	-2.554	...	-2.536
	...	(2.32) *	...	(2.28) *
Observations	672	672	672	672
R-squared	0.70	0.70	0.70	0.70

... not applicable
* significant at 5% level
Notes: Authors' calculations from data. Robust t-statistics in parentheses.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

To see if there is a difference in the effect of service offshoring on wage growth, we have introduced an interaction term of service offshoring and a dummy variable for the service-sector industries. We find service offshoring has a negative effect on wage growth in the service sector, and has little effect on wage growth in the goods-producing sector.

Table 17 presents the results on the effect of offshoring on the wages of university-educated workers relative to non-university-educated workers. We find that the material offshoring and service offshoring are not related to changes in relative wages for this group.

Table 17
Regression results on the effects of offshoring on relative wages of university-educated workers

	(1)	(2)	(3)	(4)
Offshoring	-0.033	...	...	...
	(0.35)	...	...	...
Material offshoring	...	-0.04	-0.047	...
	...	(0.42)	(0.50)	...
Service offshoring	...	1.08	...	1.102
	...	(1.14)	...	(1.18)
Observations	672	672	672	672
R-squared	0.70	0.70	0.70	0.70

... not applicable
Notes: Authors' calculations from data. Robust t-statistics in parentheses.
Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

Our findings on the effects of offshoring on wages and employment are consistent with more aggregate recent estimates of the effects of offshoring on Canadian labour markets (Trefler 2005; Morissette and Johnson 2006). Morissette and Johnson find little employment effects of offshoring. Trefler (2005) finds that the Canadian labour markets have been adjusting to service offshoring via wages rather than employment. As discussed in Trefler (2005), this is unusual as

the studies on the impact of international trade find that employment typically adjusts more than wages.[14]

Our findings on the impact of offshoring on skilled workers are different from Yan (2006), who examines the demand for non-production workers relative to production workers in Canadian manufacturing industries. Yan (2006) finds that material offshoring increases, not decreases, the demand for this more skilled category (non-production workers). But her study estimated a regression equation in levels, not in first differences as done here. The results in Yan (2006) suggest that industries with a high level of material offshoring tend to have a greater demand for more skilled workers. The results in this paper, using a first-differenced equation, suggest that growth in material offshoring reduces the demand for more skilled workers.

5 Conclusions

Outsourcing occurs as firms reorganize production processes. Buying, rather than producing, their own inputs is done by a firm to take advantage of cost savings. Trends in doing this presage major changes in the importance of large integrated firms, as opposed to decentralized supply networks with each participant doing only a small part of the work.

Firms constantly adjust their make-or-buy decisions at the margin. While examples can always be found of particular instances where the firm's margin is either expanding or contracting, the issue that we address here is whether there has been any major change on average in the degree of outsourcing across a wide range of Canadian industries. The data show that that there has been little, if any, change in the overall outsourcing of materials since 1960.

This is not the case for service inputs. The outsourcing of service inputs has been taking place for a considerable period. Service outsourcing has been greatest in the service sector. This tendency reflects several forces. First, service industries have matured from single-establishment entities to large multi-establishment firms that offer critical business services at lower costs, due to the exploitation of economies of scale. The provision of computerized payrolls is one example. The evolution of large general-accounting firms is another. In each of these cases, movement of some services that used to be provided in-house has occurred as firms in both manufacturing and services moved some production processes outside.

Those interested in outsourcing often also discuss offshoring—the tendency of inputs to be increasingly sourced abroad. Offshoring, of course, can result from increased outsourcing, or be completely separate from it. For example, material outsourcing has not increased, but material offshoring has. This is probably the result of the general move to trade liberalization that Canada has experienced over the last four and a half decades. But service offshoring has increased at the same time as service outsourcing. Service offshoring, in the case of business services, is primarily related to outsourcing, since the import intensity of business service inputs has remained relative constant over time. But in the case of other services—real estate, finance, insurance—the import ratio has gone up at the same time as service outsourcing in these areas

14. Liu and Trefler (2006) find no evidence that service offshoring reduced wages of workers in the United States.

has increased. The advantages in these areas that come from sourcing foreign services have led to a gradual increase in the share of services that are accounted for by imports.

Two factors were found to be related to the increase in offshoring—globalization and technological change related to information and communications technologies (ICTs). The share of ICT intermediate inputs is positively related to growth in offshoring in both materials and services. Industries that increased ICT inputs were more likely to increase their offshoring of services. Information-input use probably served to reduce the distance barriers for trade in services generally.

The growth in both services and material offshoring reflects the continuing trend in globalization and integration of world economies. Material offshoring reflects the two forces of globalization: gains from exploiting comparative advantage and gains from the exploitation of scale economies in differentiated product lines. Service offshoring reflects the force of scale economies and product differentiation.

But it is the impact of offshoring that is of most interest. Offshoring is related to productivity growth, shifts to higher value-added activities and changes in labour markets.

Outsourcing of products to sources outside of Canada can potentially affect the type of production that is done in Canada and also affect labour markets. Offshoring production potentially moves producers up (or down) the value chain and may affect productivity if it allows for the substitution of inefficient internally produced goods with less expensive and superior inputs from abroad.

Over the last 40 years, material offshoring was positively related to multifactor productivity (MFP) growth. In contrast, service offshoring was not related to MFP growth.

Just the opposite occurs with the relationship between offshoring and changes in the value-added chain. Service offshoring is positively related to increases in the ratio of value added to intermediate input. Material offshoring is not related to changes in the ratio of value added to intermediate inputs.

Service offshoring has been associated with a shift to higher value-added activities in Canadian industries. The growth in service offshoring is positively related to an increase in the ratio of valued added to intermediate inputs, and in high-tech capital deepening. In contrast, we find that material offshoring is not associated with shifts to higher value-added activities. The growth in material offshoring is not related to the changes in the ratio of value added to intermediate input, and in high-tech capital deepening. It is negatively related to the share of university-educated workers in total employment.

Finally, material and services offshoring has no effect on employment in Canadian industries. The effect of offshoring on wage growth differs between material offshoring and service offshoring. Material offshoring is not related to wage growth. Service offshoring has a negative relationship with wage growth in the service sector, and it has little effect on wage growth in the goods-producing sector.

Appendix

Table A.1
Outsourcing and offshoring of service inputs at the industry level

Industries	Share of services in gross output		Import share of service inputs	
	percent			
	Level in 2003	Change 1961 to 2003	Level in 2003	Change 1961 to 2003
Agriculture, forestry, fishing and hunting	11.64	5.53	8.04	6.49
Mining, and oil and gas extraction	13.29	5.58	8.22	4.84
Utilities	11.28	2.91	5.10	4.17
Construction	13.83	7.89	9.07	3.16
Food manufacturing	8.71	2.47	6.67	5.26
Beverage	18.46	3.07	7.28	5.43
Tobacco	23.96	13.54	8.22	6.88
Textile and textile product mills	8.66	2.98	6.49	4.78
Clothing manufacturing	9.09	1.59	5.57	4.39
Leather and allied products	9.32	3.12	6.92	5.26
Wood product manufacturing	6.99	1.49	6.32	4.76
Paper manufacturing	10.06	5.04	6.58	3.76
Printing and related support activities	12.51	1.68	5.64	3.14
Petroleum and coal products	6.41	0.25	8.87	7.54
Chemical manufacturing	13.89	1.51	6.56	4.79
Plastics and rubber products	10.20	2.08	7.39	6.12
Non-metallic mineral products	11.88	1.86	6.93	5.40
Primary metal manufacturing	6.61	2.95	7.25	4.75
Fabricated metal products	7.51	1.70	6.75	3.88
Machinery manufacturing	8.46	0.52	6.56	4.02
Computer and electronic products	16.88	7.05	8.32	6.17
Electrical equipment and appliances	13.38	5.25	8.00	5.80
Transportation equipment	12.24	5.37	9.49	7.13
Furniture and related products	8 90	2.04	5.79	3.86
Miscellaneous manufacturing	10.25	-0.01	6.35	4.50
Wholesale	34.50	15.36	7.05	4.80
Retail	30.64	11.38	7.22	5.05
Transportation and warehousing	31.27	10.90	8.65	5.54
Information and cultural industries	32.06	17.88	9.20	5.23
Finance, real estate and insurance	37.71	15.75	7.95	5.56
Professional, scientific and technical services	31.97	17.65	6.95	2.09
Other services of the business sector	22.65	10.66	5.43	3.80
Simple average	15.79	5.85	7.21	4.95

Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

Table A.2
Outsourcing and offshoring of material inputs at the industry level

Industries	Share of materials in gross output		Import share of material inputs	
	percent			
	Level in 2003	Change 1961 to 2003	Level in 2003	Change 1961 to 2003
Agriculture, forestry, fishing and hunting	44.29	17.16	15.71	2.72
Mining, and oil and gas extraction	14.64	1.49	22.50	3.33
Utilities	3.49	1.27	49.95	49.51
Construction	44.59	-9.13	29.09	13.74
Food manufacturing	63.28	-5.64	19.44	3.10
Beverage	35.77	6.48	26.62	8.71
Tobacco	21.20	-40.43	13.19	9.10
Textile and textile product mills	51.07	-8.44	62.53	21.78
Clothing manufacturing	46.54	-6.37	52.87	17.12
Leather and allied products	50.10	-1.78	66.73	36.76
Wood product manufacturing	54.80	-0.57	11.85	4.01
Paper manufacturing	49.36	3.43	26.87	17.48
Printing and related support activities	40.62	2.67	43.18	30.65
Petroleum and coal products	78.66	6.03	47.68	-2.87
Chemical manufacturing	44.89	2.13	44.05	15.37
Plastics and rubber products	49.74	-0.38	57.21	21.89
Non-metallic mineral products	38.98	2.14	26.90	7.89
Primary metal manufacturing	57.69	-0.14	40.83	16.39
Fabricated metal products	48.62	-1.40	33.68	15.62
Machinery manufacturing	49.38	5.70	53.30	25.04
Computer and electronic products	53.05	14.43	71.76	31.98
Electrical equipment and appliances	52.12	2.97	53.49	31.37
Transportation equipment	62.82	6.34	65.44	24.91
Furniture and related products	47.30	-0.69	36.96	13.57
Miscellaneous manufacturing	45.08	1.00	55.38	22.69
Wholesale	3.34	-5.39	32.65	26.21
Retail	2.67	-5.85	22.34	16.43
Transportation and warehousing	5.89	-1.25	45.51	27.94
Information and cultural industries	10.43	-3.33	37.58	29.00
Finance, real estate and insurance	2.07	-2.67	2.57	2.31
Professional, scientific and technical services	6.89	0.99	9.12	3.75
Other services of the business sector	14.21	-10.31	21.07	11.77
Simple average	37.30	-0.92	37.44	17.48

Note: Authors' calculations from data.
Source: Statistics Canada, Input–Output Accounts.

Table A.3
Major information and communications technology commodities, ranked by contribution to the ICT[1] sector output

ICT commodity		Commodity type
1.	Telephone and other telecommunications	Services
2.	Computer systems design and related services	Services
3.	Telephone and related equipment, including facsimile	Goods
4.	Software products development	Services
5.	Computers, video units, printers, etc.	Goods
6.	Cable and other subscription programming	Services
7.	Integrated circuits	Goods
8.	Broadcasting and radio communications equipment	Goods
9.	Printed circuits	Goods
10.	Data processing services	Services
11.	Lab and scientific instruments, and flight simulators	Goods
12.	Wire and cable, insulated, excluding aluminium	Goods
13.	Semi-conductors	Goods
14.	Measuring and controlling instruments	Goods
15.	On-line information services	Services
16.	Radar and radio navigation equipment	Goods
17.	Optical fibre cables	Goods
18.	Service industry machinery	Goods
19.	Other information services (including news syndication, microfilm, recording, etc.)	Services
20.	Photocopy and microfilm equipment	Goods
21.	Radio, stereo, cassette and CD players, and accessories	Goods

1. Information and communications technology.

Notes: Photocopy and microfilm equipment excepted, all the goods listed are cross-classified as ICT manufacturing goods by the Organisation for Economic Co-operation and Development (2001).

Source: Statistics Canada, 1999 Supply Table, Canadian Input–Output Accounts.

Table A.4
Summary statistics

	Mean	Standard deviation
Changes in service offshoring	0.0006	0.0016
Changes in material offshoring	0.0020	0.0086
Changes in intra-industry trade/output ratio	0.0063	0.0182
Changes in inter-industry trade/output ratio	0.0019	0.1534
The share of ICT[1] in investment	0.1119	0.1629
Changes in the share of ICT in intermediate inputs	0.0004	0.0045
Changes in multifactor productivity based on value-added	0.0095	0.0430
Changes in the ratio of intermediate input to value-added	-0.0049	0.0381
Changes in hours worked of university-educated workers relative to non-university workers	0.0418	0.0508
Changes in ICT capital/hours ratio	0.1646	0.1225
Changes in hours worked	0.0143	0.0406
Changes in wages	0.0618	0.0369
Changes in wages of university-educated workers relative to non-university workers	-0.0079	0.0414

1. Information and communications technology.

Notes: This table shows results of the authors' calculations. All changes are annual changes. The decline in the relative wages of university-educated workers in the sample period from 1961 to 2003 reflects the decline in the relative wages of university-educated workers in the 1960s and 1970s. For more on this decline, see Appendix Table 3.A3 in Gu, Kaci, Maynard and Sillamaa (2002).

Sources: Statistics Canada, Input–Output Accounts and Productivity Accounts.

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